fore the numerous questions raised by our feeding trials can be regarded as settled, and attention must finally be given to the relative food value of mixtures of various food stuffs with corn meal, so that we may know as definitely as possible the most economical combinations to employ in maintaining mature animals and in raising the young. Such experiments must be conducted on a large scale and with a variety of domestic animals. In carrying these out the results obtained by the method I have just described when combined with the experience gained in feeding animals for market will doubtless lead to a lower cost of meat production, and at the same time give us information which will contribute to a clearer understanding of some of the obscure problems of the chemical physiology of nutrition.

THOMAS B. OSBORNE
CONNECTICUT AGRICULTURAL EXPERIMENT STATION,
NEW HAVEN, CONN.

DISCOVERY OF BIVALVE CRUSTACEA IN THE COAL MEASURES NEAR PAWTUCKET, R. I.

WHILE collecting fossils for the Museum of Comparative Zoology, Cambridge, from the Carboniferous graphitic slates of Central Falls, Rhode Island, last June, the writer discovered in a half inch layer at two localities one hundred yards apart about two dozen, more or less well preserved impressions of carapaces of bivalve crustacea of the genera *Leaia* and *Estheria,* in the same layer with numerous plant impressions, chiefly leaves of Cordaites and Calamites. No record of their having been previously discovered in the Narragansett Basin Coal Measures was found by the writer, and no specimens of any bivalve crustacea occur in the collection of Coal Measure material from the basin, at Brown University or at Harvard.

The faunal remains from the Narragansett Basin Coal Measures are comparatively meager, and consist largely of tracks which are in many cases of doubtful determination. Previous to the year 1900, fourteen species of insects and one arachnid were identified by Scudder,[1] and the tracks of a probable annelid and of a mollusc or worm were described.[2] In 1900 A. S. Packard[3] described some probable worm tracks, and those of a possible crustacean which were found in some red shale boulders at South Attleboro. He described and named another track found in a pebble of arenaceous shale in a kame in North Providence, and three fragments of a possible macrurous crustacean from the black shales of Valley Falls, R. I., and noted a locality near East Attleboro, shown to him by Professor J. B. Woodworth, where sand-filled worm borings occur in the red and green shales. He also described and identified several casts of valves of a fresh-water mollusc *Anthracomya arenacea* (Dawson) Hind, from a boulder of fine black shale at Valley Falls, and one specimen from a shale bed north of Silver Spring, East Providence.

Numerous supposed amphibian tracks have been found by Professor J. B. Woodworth near Plainville, Mass., and one species, *Batrachichnus plainvillensis,* has been described[4] and named by him. Since then he and the writer have found many types of tracks from several localities near Plainville, and these will probably be described in detail soon. Two or three tracks of probable amphibia were found by Professor Woodworth and the writer last June at Valley Falls and Central Falls, R. I., which is very much south of the localities where they have been previously noted.

From this brief summary of the occurrence of the fossil fauna, it will be seen that only a part of the specimens have been found *in situ,* and the majority of these are tracks. The discovery of these bivalve crustacea in place is therefore of considerable importance.

The impressions of the valves of *Leaia* and *Estheria* occur in a grayish black, somewhat graphitic slate bed along the south bank of the Blackstone River in Central Falls, R. I. The beds strike N. 70°–80° E. about parallel with the river at this place, and dip 70° N.

[1] Bull. U. S. Geol. Survey, No. 101, 1893.

[2] *Proc. Bost. Soc. Nat. Hist.,* XXIV., 1889, pp. 209–216, and *Amer. Jour. Sci.,* 3d Ser., XXXVII., 1889, p. 411.

[3] *Amer. Acad. Arts and Sci. Proc.,* Vol. XXXV., 1900, pp. 399–405.

[4] *Geol. Soc. Am. Bull.,* Vol. IX., 1900, pp. 449–454.

The section consists of alternating slate and gray sandstone layers, of a few feet thickness. The slate usually has numerous fossil plant impressions in it, but the sandstone here is barren of recognizable organic remains.

The specimens of the genus *Leaia* Jones, are in general well preserved and show the surface markings distinctly (see Fig. 1).

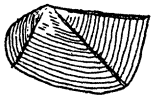

FIG. 1. X 2.

FIG. 2. X 2.

They correspond closely with the description and figures of *Leaia tricarinata* Meek and Worthen,[5] of the Illinois and Indiana Coal Measures. The size of an average specimen from Rhode Island is: length, 8.5 mm.; height, 5 mm. The presence of a well-marked third carina along the dorsal margin and the twelve to sixteen slender concentric ridges, as well as the agreement in size, make it seem safe to call the Rhode Island specimens *Leaia tricarinata.*

Several specimens of the genus *Estheria* Ruppel occur in the same layer with *Leaia* (see Fig. 2). They vary slightly in size and proportions, but all show the generic characters well. The surface markings are not as distinct as in the specimens of *L. tricarinata,* but most of the *Estheria* specimens show from nine to thirteen faint concentric striæ. The size of an average specimen from Rhode Island is: length, 7 mm.; height, 5 mm. The specimens are not sufficiently well preserved to permit of a specific determination.

In the Conemaugh Series of the Carboniferous of Pennsylvania, Dr. P. E. Raymond[6] has noted the presence of *Estheria* and *Leaia tricarinata,* with plant remains, in a red and gray shale layer occurring just below the Ames limestone, which is midway in the Conemaugh Series. Fossils of the two genera occur in several horizons of the Coal Measures. In Illinois *L. tricarinata* ranges from the lower part of the Lower True Coal Measures, to high up in the Upper Coal Measures, therefore neither genus is a good horizon marker. If we regard the *Estheria, L. tricarinata* horizon of the Conemaugh Series as of the same age as that at Central Falls, R. I., we should then be calling this horizon of the Narragansett Basin Series the equivalent of the middle of the Lower Barren Measures of Middle Pennsylvanian age.

WINTHROP P. HAYNES
CAMBRIDGE, MASS.,
October, 1912

[5] *Geol. Surv. Ill.,* Vol. 3, pp. 541–543.

[6] *Ann. Carnegie Mus.,* Vol. V., No. 2 and 3, 1909, p. 173.

THE ELECTROMOTIVE FORCE PRODUCED BY THE ACCELERATION OF CONDUCTORS

THE possibility that electromotive forces may be produced by the mechanical acceleration of electric conductors was first thoroughly considered by Maxwell,[1] and the actual presence of such electromotive forces in *electrolytic* conductors was shown by Colley[2] in 1882.

The desirability of obtaining similar electromotive forces in accelerated *metallic* conductors has long been recognized by the writer. At a meeting of the Harvard and Massachusetts Institute of Technology Physical Chemical Society, held at the Harvard Union in the spring of 1906, he stated that a potential difference was to be expected between the front and rear ends of a metallic conductor which is suddenly stopped, since there will be a tendency for the electrons to continue in motion. Since that time he has often spoken to his colleagues, both privately and at informal scientific meetings, of the desirability of making measurements of this kind in order to obtain information as to the mass of the carrier in metals, and in particular has described as a possible form of apparatus a coil of wire oscillating about its own axis with some form of commutator to permit the detection with an ordinary galvanometer of the alternating current which would be generated.

During the past year at the University of Cincinnati, with the help of his assistant, Mr. Earl W. Osgerby, the writer has carried out

[1] Maxwell, "Treatise on Electricity and Magnetism," 3d edition (1892), Vol. II., 211 et seq.

[2] Colley, *Wied. Ann.,* 17, p. 55, 1882.